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EXAMINER	
ZERVIGON,R	
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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

FILE COPY

Office Action Summary	Application No. 08/988,246	Applicant(s) Sebastien et al
	Examiner Rudy Zervigon	Group Art Unit 1763

☐ Responsive to communication(s) filed on ______.

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire *3* month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1-10* is/are pending in the application.

Of the above, claim(s) *7-10* is/are withdrawn from consideration.

☐ Claim(s) ______ is/are allowed.

☒ Claim(s) *1-6* is/are rejected.

☐ Claim(s) ______ is/are objected to.

☒ Claims *7-10* are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on ______ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on ______ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) ______.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: ______.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). *2*

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-4 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Robertson et al in view of E. van de Van et al, Provence et al, and Patrick et al (U.S. Pat. No. 5,474,648). Robertson et al describes, according to BSUM(11), a typical plasma-assisted CVD apparatus. Robertson et al state that the *substrate* to be processed is positioned within a *reaction zone* (item 214, Figure 2A) on a *lower*, grounded platen *electrode (item* 216, Figure 2A), while *the RF power is applied to the upper electrode* rectangular face plate *(item* 292, Figure 2A) having hundreds of orifices *(item* 293, Figure 2A) through which process gas and purge gas ultimately meet the substrate *(item* 215, Figure 2A). The process gas and purge gas jointly make up *a gas distribution system including a gas inlet manifold for supplying at least one process gas to the reaction zone.* An *RF power supply* and matching network *(item* 228, Figure 2A) create and sustain a process gas plasma from the inlet gas issuing from the *upper electrode* rectangular face plate *(item* 292, Figure 2A). The reactant gases are discharged in the region of the upper electrode and a *plasma forms between the two electrodes.* The close proximity of the reactor chamber walls to the plasma zone increases the

amount of deposition on the chamber walls and increases the possibility for arcing between the platen electrode and the chamber walls. In addition, according to DETD(6), the author's method and apparatus enable the operation of plasma-enhanced chemical vapor deposition processes within the reactor chamber (item 22, Figure 2A) with reduced film deposition upon reactor chamber walls. However, Robertson et al do not explicitly provide for a *RF powered lower electrode*. In addition, Robertson et al does not provide for a *gas inlet manifold for supplying one or more process gases.* E. van de Van et al, however, discuss the advantages of PECVD dual frequency electrode design. Specifically E. van de Van et al show a dual frequency PECVD electrode design as their depiction in Figure 1. The authors state that the use of dual frequency for PECVD provides increased flexibility and process control (conclusions). Provence et al describe a semiconductor manufacturing apparatus for etching a *substrate* which is a subtractive process. Provence et al does not describe the claim 1 limitation of a deposition chamber. However, the plasma reactor and control system described by Provence et al does embody a majority of limitations described in claim 1.

Specifically, according to DETD(55), Provence et al describes *gas distribution* 43 of FIG. 1 is applied to a *gas inlet manifold* 750 by a mass flow controller 721 through 724. The mass flow controllers are controlled by the analog inputs from the *computer* 10 and additionally valves 710 through 713 are controlled by the status I/O 3 of the *computer* 10 and are on/off valves. The gases mixed in the *gas inlet manifold* 750 and applied to the *plasma chamber* 37 where the temperature of the reaction within the *plasma chamber* is monitored by a thermocouple 751. The thermocouple 751 is an analog

input to the analog I/O 5 of the *computer* 10. A vacuum pump 31 pulls a vacuum in the *plasma chamber* 37 when the block valve 709 is open. The flow rate is controlled by a throttle valve 708 which position is fed into the analog input and is set by the output from the analog input of the *computer* 10. Sensors 2 senses the position of the silicon wafer within the *plasma chamber* 37. The vacuum of the entry load lock 21 and the exit load lock 49 is provided by pump 29. The pump rates, and thus the system *pressure*, are controlled by throttle valves 704 and 706. The gate valves are interfaced in the *computer* 10 at the digital I/O 3 and the throttle valves 704 and 706 are controlled by the analog I/O card 5.

In addition, according to DETD(63), the *substrate* is moved from the entry load lock 21 through a second isolation gate 35 into the main chamber 37 and placed on a main chamber *substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode*. This is accomplished in the same manner as was discussed in conjunction with FIGS. 1--18. In addition, according to DETD(69), the control of plasma discharge which occurs during the reactor process between the *substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 230 and the *substrate* 206. The electrode assembly includes an *substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 230 to which RF voltage is applied via attachment to the plate 250. Provence additionally describe, according to DETD(73), illustrates in FIG. 32 an *first electrode 987* includes feedthrough 886 and O ring seals 981 and includes a *gas distribution*

assembly 889, a retainer 888 that holds the *second electrode 890* onto the *gas distribution assembly 889*. The retainer 888 also seals the electrode assembly 987 to the walls of the collimator 891, which is made of insulating materials. The gas is distributed through the *second electrode 890* by means of a plurality of *gas distribution* holes 991. Provence additionally describes, according to DETD(3), *gases* provided by the *gas distribution 43* and the filters 45. And RF power is provided to the main chamber 37 by an RF generator 51 and is applied to an RF matching network 53 by a conductor 55.

Provence et al does not explicitly describe an *impedance monitor electrically coupled to the deposition chamber to measure the impedance level of the plasma.* However, Roger Patrick et al. (USPat5,474,648) describe a dynamic control and delivery of radio frequency power in plasma process systems. The processing is utilized to enhance the repeatability and uniformity of the process plasma. Power, voltage, current, phase, *impedance*, harmonic content and direct current bias of the radio frequency energy being delivered to the plasma chamber may be monitored at the plasma chamber and used to control or characterize the plasma load. Dynamic pro-active control of the characteristics of the radio frequency power to the plasma chamber electrode during the formation of the plasma enhances the uniformity of the plasma (ABSTRACT).

In addition, according to the following excerpt from column 3, the claim 1 limitation of *an impedance monitor electrically coupled to the deposition chamber to measure an impedance level* of the process plasma is explicitly met:

ling the radio frequency energy with a computer system. In addition, the voltage, current, phase and impedance of the plasma chamber electrode may also be measured and the measurement information used by the computer power con-

From column 4:

4

trol system of the present invention.

A control system that monitors and controls the radio frequency power at the plasma chamber electrode is illustrated in FIGS. 2A and 2B. This radio frequency power control system includes a radio frequency sensor placed closely to the plasma load electrodes in the plasma etching

In addition, according to BSUM(24), The Patrick et al sensor may also measure the voltage, current and phase angle at the chamber electrode, *and measure the chamber impedance as desired.* In addition, Patrick et al describe a radio frequency ("RF") generator 102 as shown in Figure 2A is coupled to a plasma chamber 104 through a matching network 120 consisting of *variable capacitors* 106 and 108, and coil 110. The plasma chamber 104 includes *a second RF electrode* 112 and a *first substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 114. a *substrate* 116 is in planar communication with *the substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 114. An RF excitation is created between *a second RF electrode* 112 and a *first substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 114, and when a process gas or gases (not illustrated) is introduced into the plasma chamber 104, the gas turns into a plasma. The plasma reactively etches the surface of the *substrate* 116. In addition, according to DETD(4), the maximum transfer of RF power from the RF generator 102 to the plasma

chamber 104 *second RF electrode* 112 and a *first substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 114 results when the plasma *chamber 104 load impedance* is matched to the impedance of the RF generator 102. The values of coil 110 and *variable capacitors* 106 and 108 are selected for an appropriate impedance transformation between the RF generator 102 and the plasma chamber 104 *second RF electrode* 112

and a *first substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF electrode* 114. *Variable capacitors* 106 and 108 may be *automatically adjusted* by a computer processor to obtain a substantially resistive termination for the RF generator 102. The claim 3 limitation of *a computer processor communicatively coupled to an impedance monitor where the computer processor receives the measured impedance as an input the measured impedance level of the process plasma* is explicitly met according to BSUM(22):
a dynamic control of the radio frequency energy with a computer system is accomplished. In addition, the voltage, current, phase and impedance of the plasma chamber electrode may also be measured and the measurement information used by the *computer* power control system of the present invention. In addition, according to BSUM(27), the power sensor connects to a *computer* power controller that uses the sensor information to dynamically and pro-actively control the output
power of the radio frequency power generator so that a desired power profile over time is available.

Patrick et al do not explicitly describe all the claim 1 limitations. With the Robertson et al plasma-assisted CVD apparatus as a footing, a person of ordinary skill in the art at the time the invention was made would find the enhancements taught by the other sighted references obvious enhancements over the Robertson et al design. Motivation for combining the above references include the enhanced plasma control as taught by Evert P. van de Ven and chamber impedance control for enhanced sheath charge density as discussed by Patrick et al.

3. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Robertson et al as applied to claims 1-4 above, and further in view of Boys et al. Boys et al describe a magnetron sputter coating apparatus controlled in response to measurements of plasma parameters to control deposition parameters (abstract). Specifically, according to DETD(11), the current supplied by source 25 to coil 21, and the voltage, as well as current supplied by DC source 37 to target cathode 15 and anode 16. Source 25 includes a current transformer (not shown) for supplying lead 44 with a DC signal proportional to the current supplied by the source to coil 21. DC plasma power source 37 includes a current transformer (not shown) for supplying to lead 46 a DC signal proportional to the current supplied by source 37 between electrodes 15 and 16. *Pressure gauge 47* supplies lead 52 with a DC signal *having a magnitude proportional to the vacuum pressure in volume 13*. Flow meter 34 supplies a DC signal to lead 35 indicative of the flow rate of working gas flowing from pressurized gas source 31 to processing volume 13. In addition, according to DETD(9), DC power sources 25 and 37 are supplied from a primary, *AC power source connected to terminal 38*. Generally, power source 25 derives a variable current that is supplied to coil 21, allowing compensation for changes in coil resistance due to temperature changes. Source 37 is controlled so that *variable* current and voltage can subsist between target cathode *second RF cathode electrode* 15 and a *first substrate holder that positions the substrate in the reaction zone while supporting the substrate atop a first RF anode electrode* 16. DC sources 25 and 37 are utilized for targets *second RF cathode electrode 15* made of magnetic or non-magnetic electrically conductive material. If, however, target *second RF cathode electrode 15* is made of a dielectric material, source 37 is an RF source, while source 25

remains a DC source. In addition, according to DETD(13), CPU *computer* 57 includes a conventional memory for storing a program and predetermined data for controlling the operation of sources 25 and 37, as well as orifice 32. CPU 57 is responsive to signals indicative of the desired voltage to be applied by source 37 between electrodes *second RF cathode electrode 15* and 16 and for the current to be supplied by source 37 between electrodes *second RF cathode electrode 15* and 16, as well as a desired value for the pressure in processing volume 13. The desired values for the voltage and current of source 37 and the pressure in volume 13 can be preset by an operator to initial values, or can be derived from the operator setting a desired rate of deposition for material from target cathode *second RF cathode electrode 15* to substrate 14. The set values for the voltage and current of source 37 and the *pressure* of processing volume 13 can be changed from time to time by the operator. The programmed values for the voltage and current of source 37 and the *pressure* in volume 13 are stored in the memory of CPU 57. Boys et al do not describe all of the limitations set forth in claims 1-4, however, with the Robertson et al plasma-assisted CVD apparatus as a footing, one of ordinary skill in the art at the time the invention was made would consider the pressure control system as described by Boys et al to be an obvious extension to the Patrick et al control system and impedance data collection and processing. Motivation for combining the above references follows from the desire to control plasma process attributes as discussed by the motivational statements of the references incorporated in this office action.

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Bialko et al. U.S. Pat. 4,315,333.

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Rudy Zervigon whose telephone number is (703) 305-1351. The examiner can normally be reached on a Monday through Friday schedule from 8am until 5pm. The official AF fax phone number for the 1763 art unit is (703) 305-3599. Any Inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Chemical and Materials Engineering art unit receptionist at (703) 308-0661.

Art Unit: 1763

Rudy Zervigon - RZ

March 19, 1999

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